Vision and Bioluminescence in Deep-sea Crustaceans

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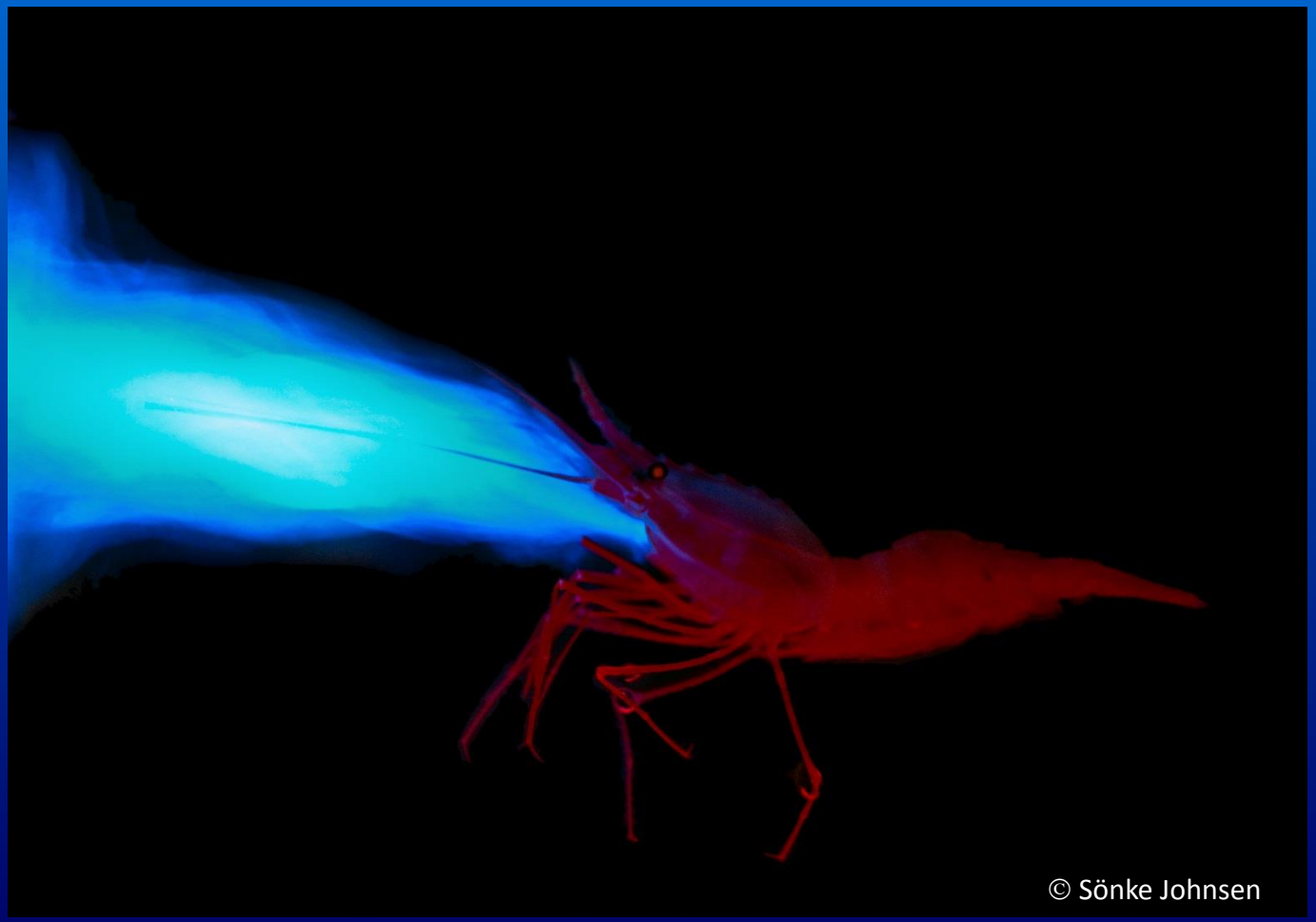
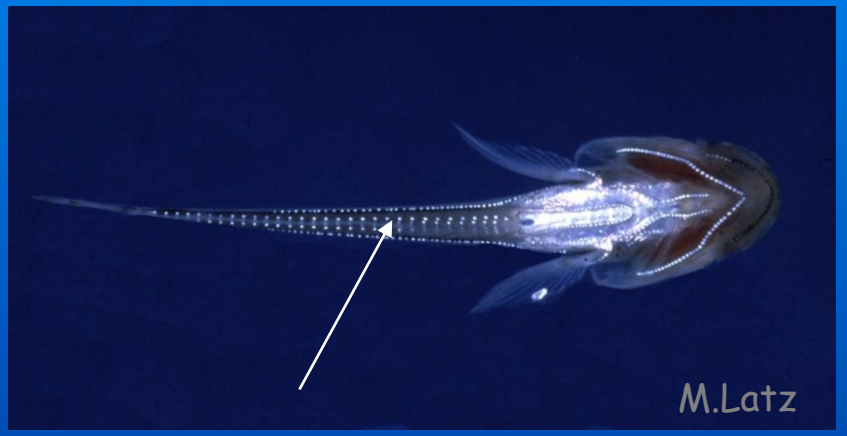
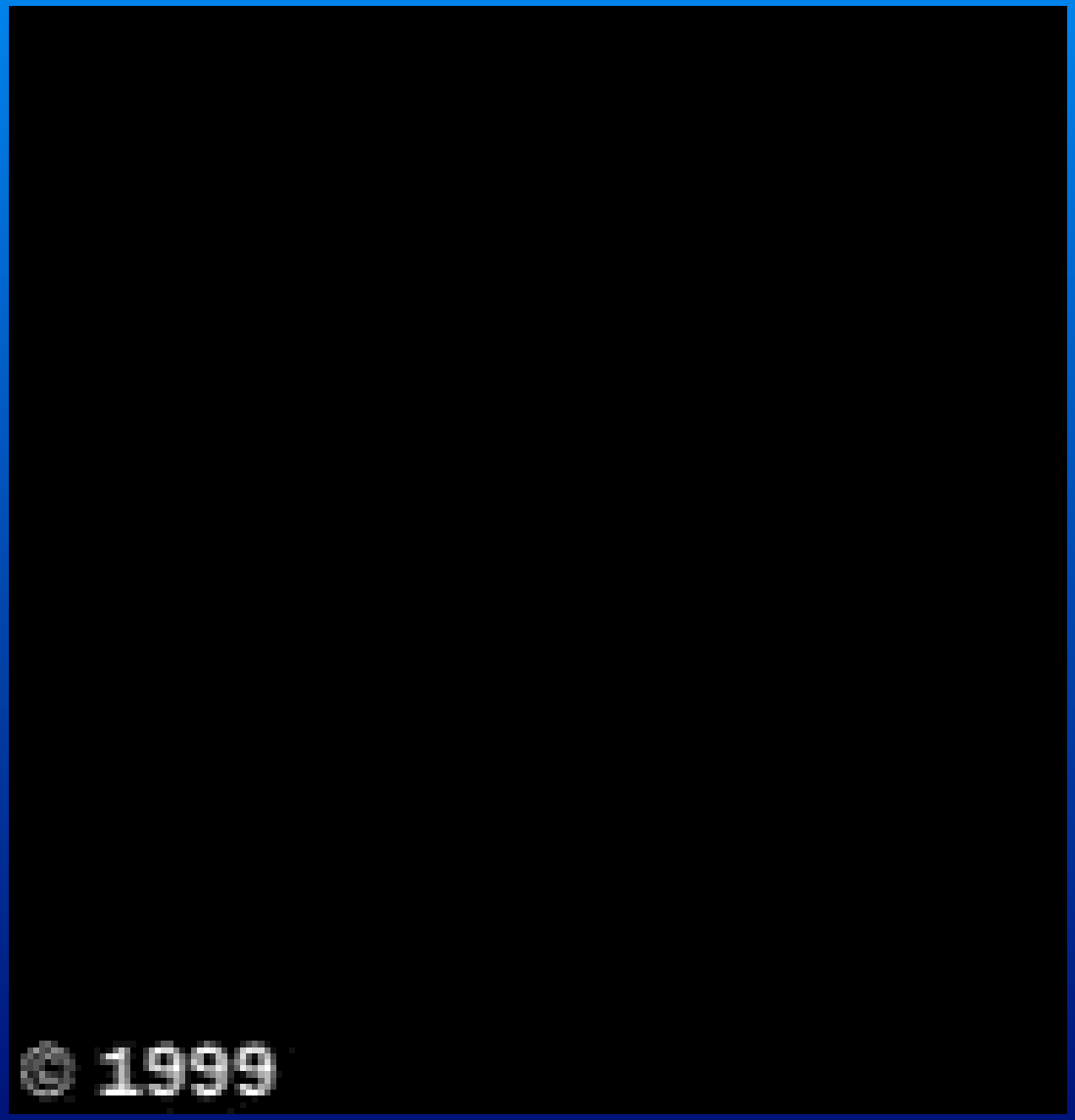


- Mesopelagic zone (200 – 1000 m depth) 90% of the animals are bioluminescent

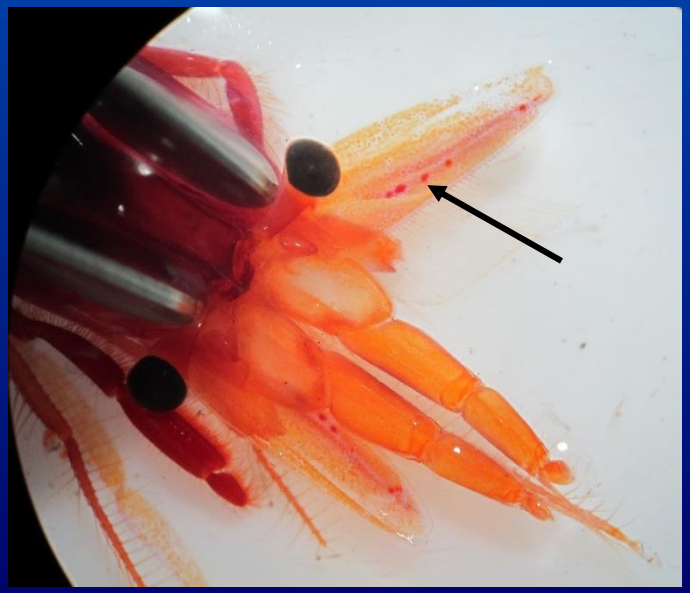
- Two forms:

1) Photophores
   – light emitting organs
   used for counterilluminaton




© 1999

How are they able to exactly match the irradiance of downwelling light to counterilluminate?



Heather Bracken-Grissom – FIU – discovered opsins (precursors to visual pigments) in the ventral photophores of 4 species of oplophorid crustaceans

- Basis of new NSF –DEB grant – Heather Bracken-Grissom, Tamara Frank, Megan Porter
  - Study light-emitting organs in Oplophorids and Sergestids

Photophores, 2 vps

No photophores, 1 vp

Photophores, 2 vps

Oplophorids

Organ of Pesta, 1 vps

Photophores, 1 vp

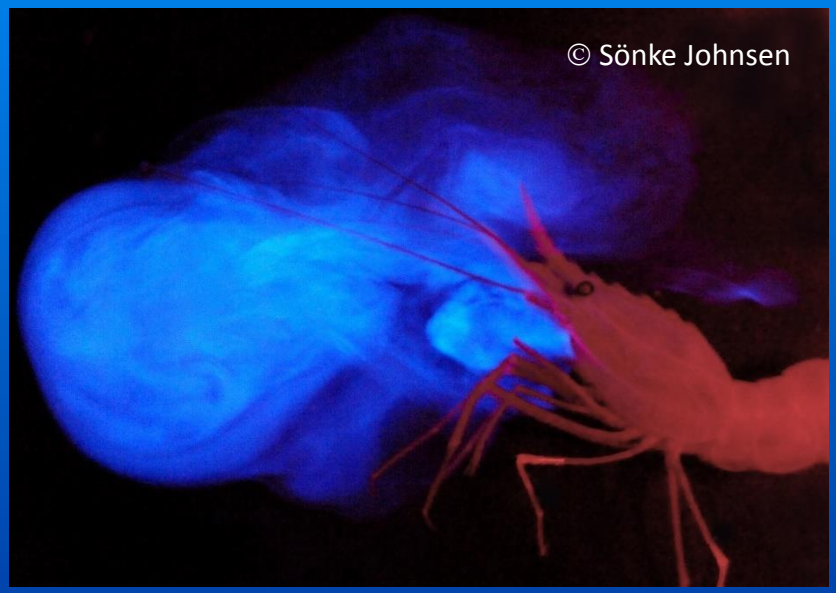
Sergestids

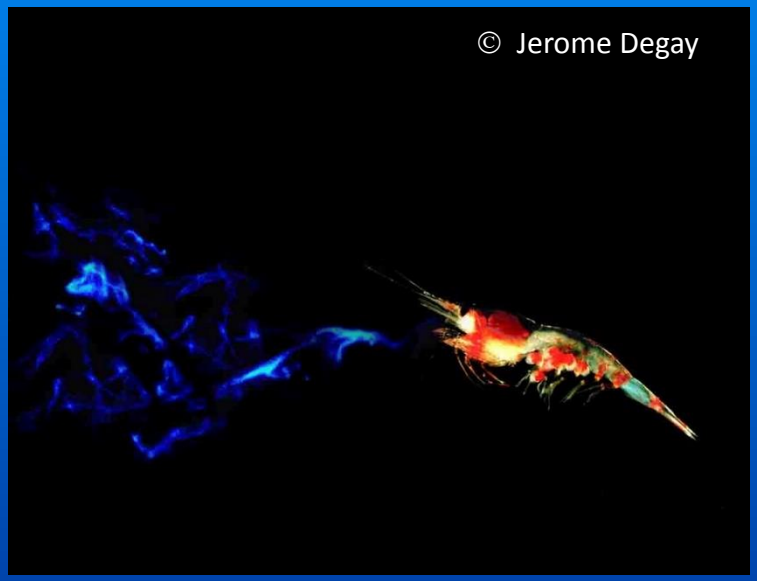
1) Identify presence of opsins and phototransduction genes in photophores – Heather and Megan

2) Record electrophysiologically from photophores of live deep-sea species to determine if they respond to light

3) Conduct studies on ultrastructure of photophores to look for other structures associated with phototransduction

2) Bioluminescent spew





- always used for defense

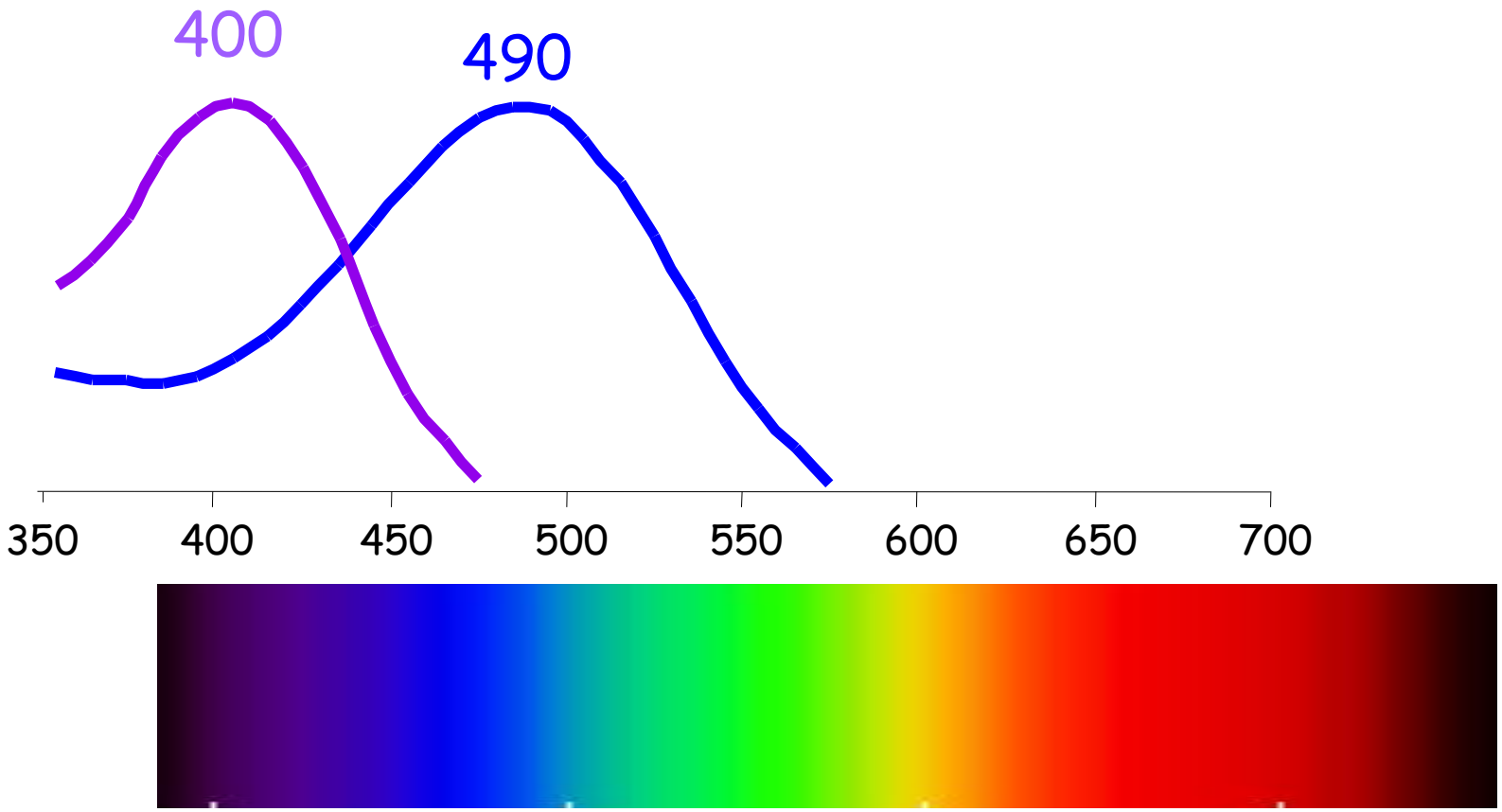
- Some crustaceans have photophores; some have a spew

* Only 7 known species (3 genera) have both spew and photophores

Systellaspis

Oplophorus

Janicella spinacauda

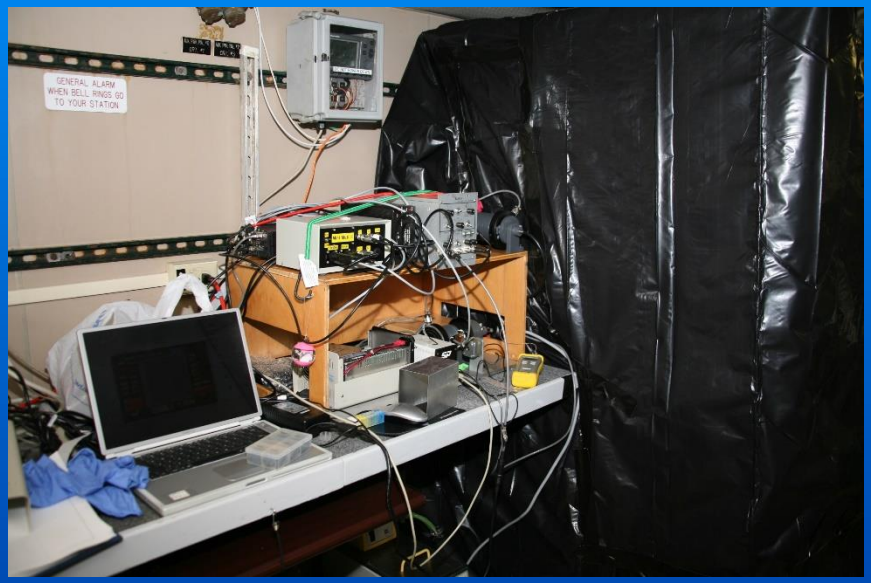


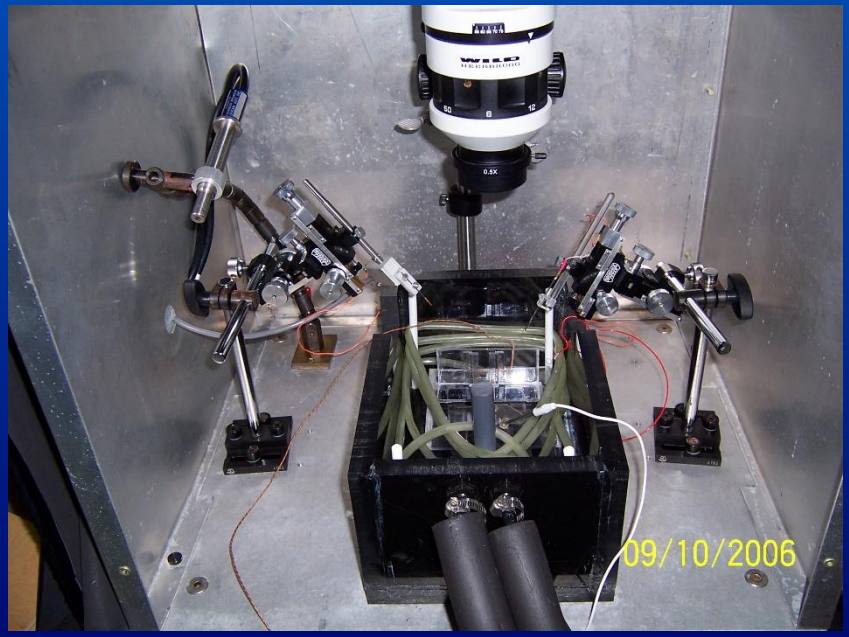
Wavelength (nm)

- Possess the expected blue sensitive visual pigment
- Only deep-sea species (until recently) known to possess a UV sensitive visual pigment

Timer release mechanism allows net to be opened and closed at depth

Removable thermally insulated, light-tight cod-end


GENERAL ALARM
WHEN BELL RINGS GO
TO YOUR STATION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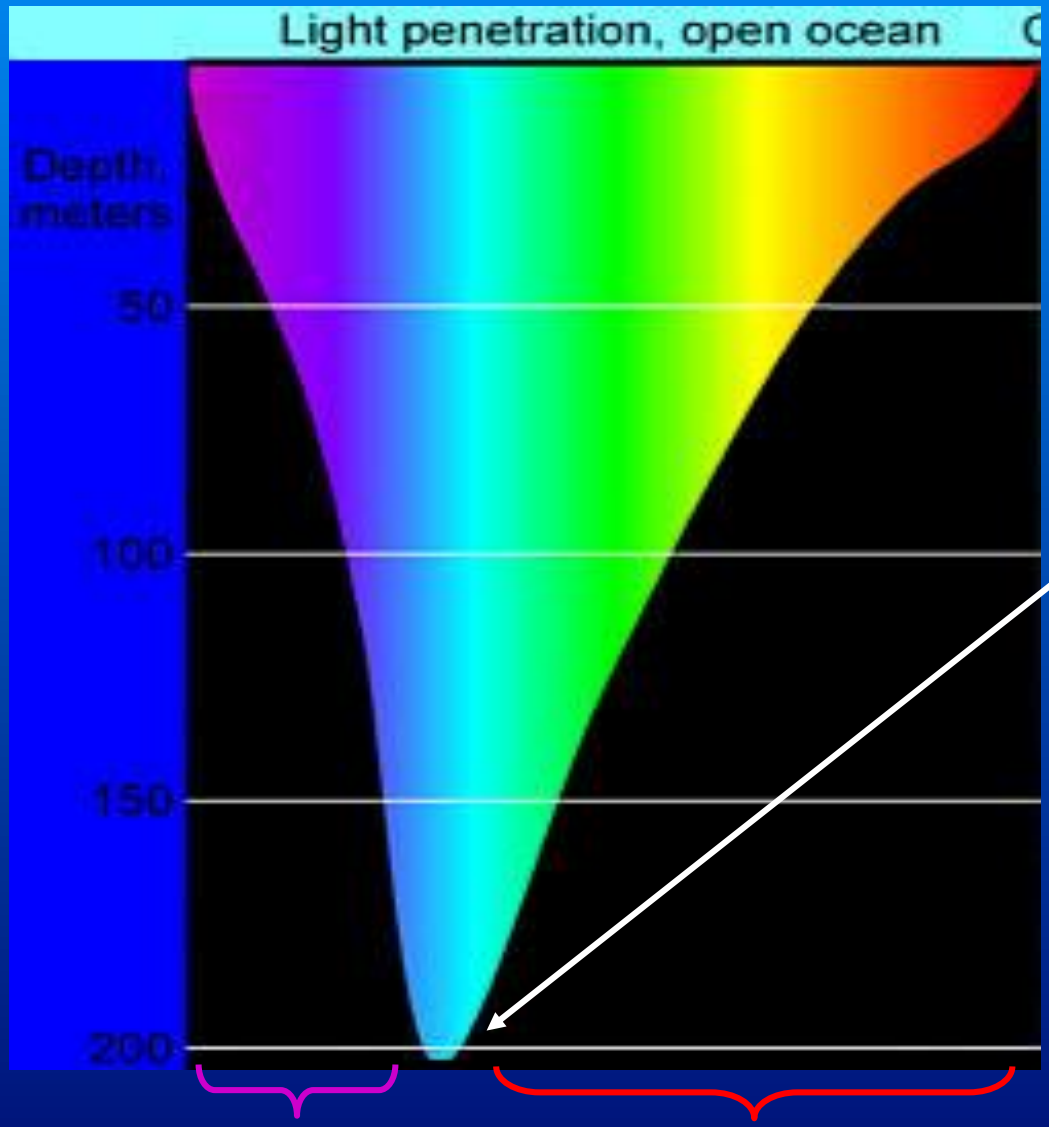
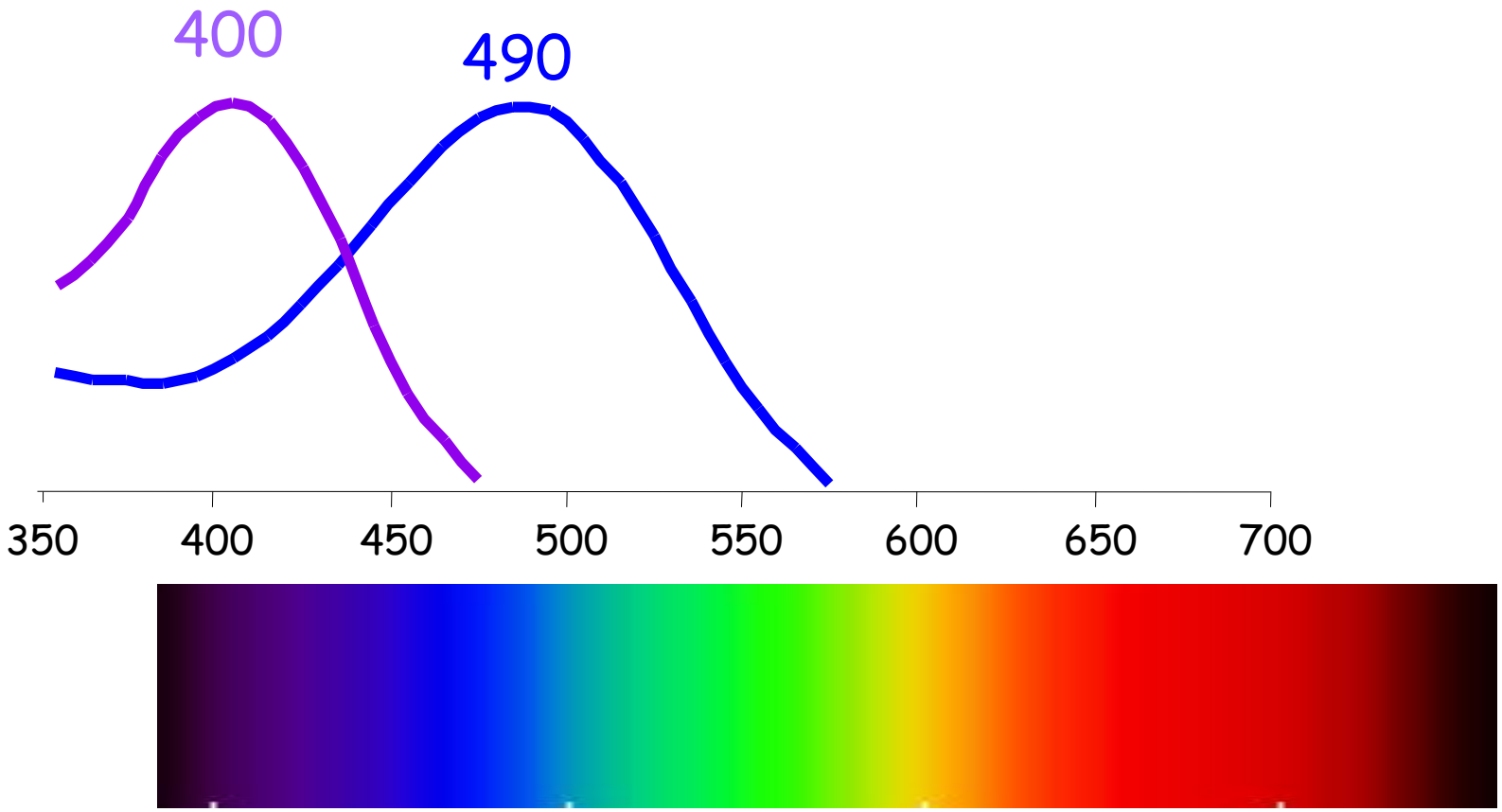
Spectral Distribution of Light Varies With Depth



*Deep-sea: only blue light remains

http://www.union.edu/PUBLIC/GEODEPT/hollocher/kth/illustrations_page.htm



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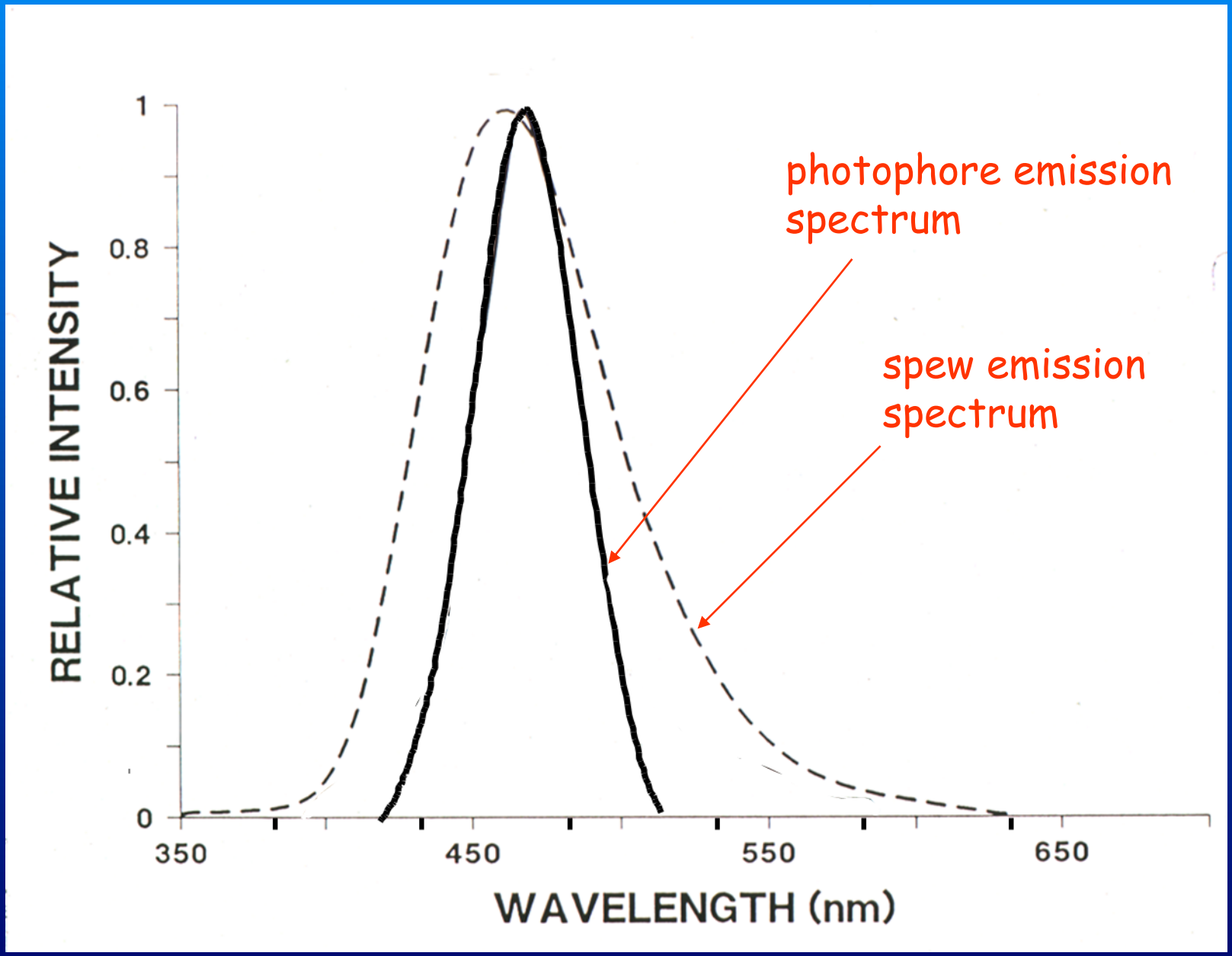

RELATIVE INTENSITY
1
0.8
0.6
0.4
0.2
0
350
450
550
650
WAVELENGTH (nm)
photophore emission spectrum
spew emission spectrum

Benthic species – studied species living on the bottom between 500 and 1900 m – funded by NOAA Office of Ocean Exploration and Research

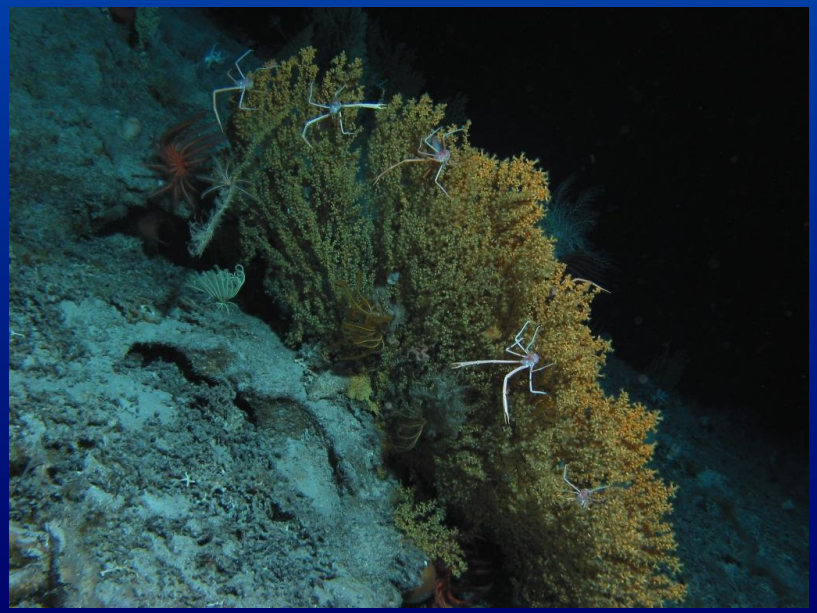
blue visual pigment

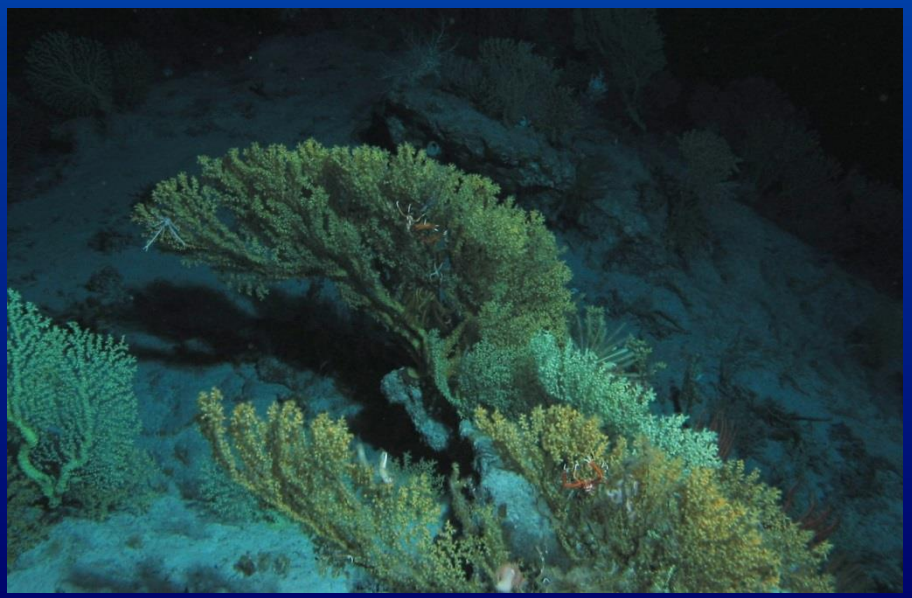
Two species also have a UV visual pigment in addition to the blue sensitive visual pigment

Gastroptychus spinifer

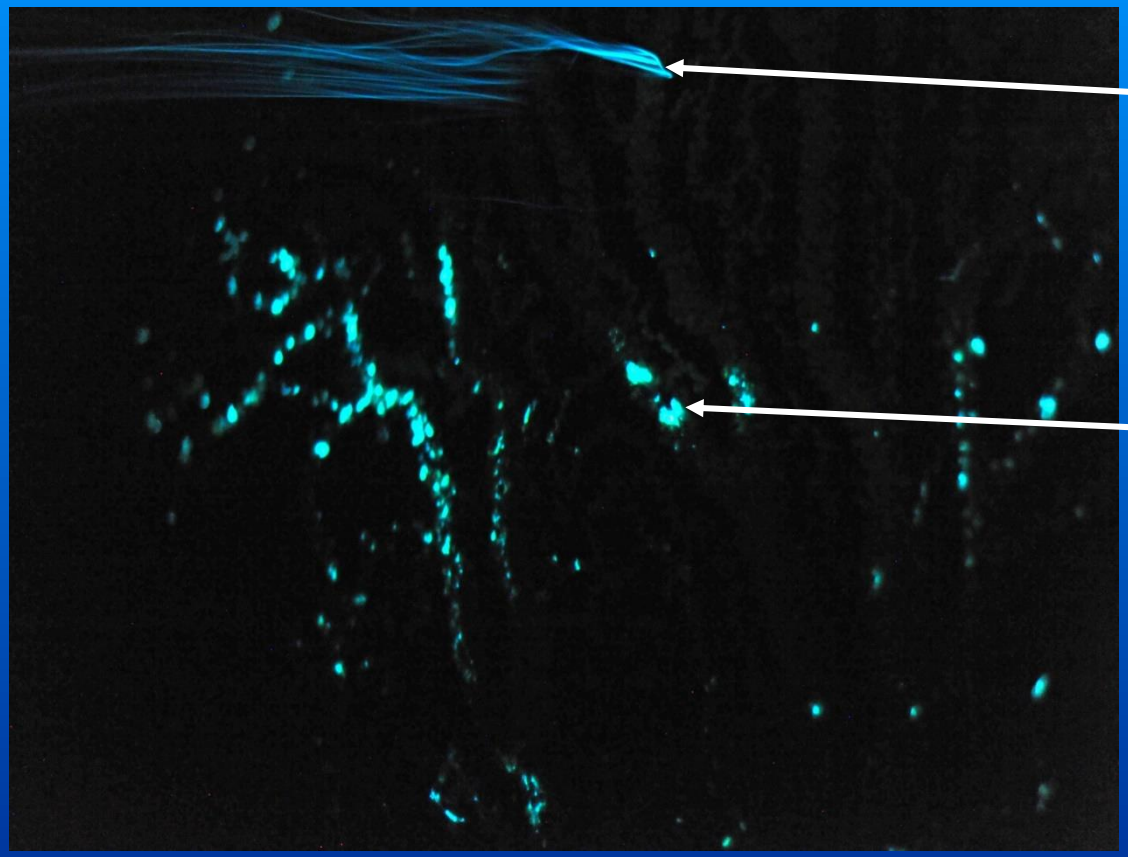
Eumunida picta

* These species are not bioluminescent






10:04:58 07/27/09
DEPTH TEMP SALIN
2023FT 12.9C 35.7



Pelagic bioluminescence
- blue shifted

Benthic bioluminescence
- green shifted

The crabs may be using two visual pigments to help them color code their food

OER funded research cruise in 2015 - two additional species have a UV visual pigment in addition to the blue sensitive visual pigment

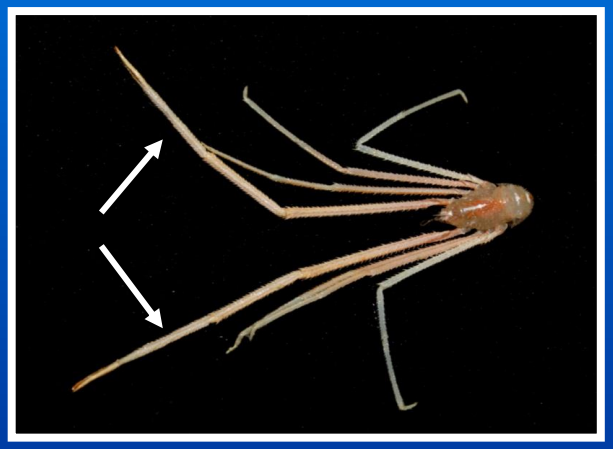
- again, neither of them are bioluminescent

Uroptychus nitidus

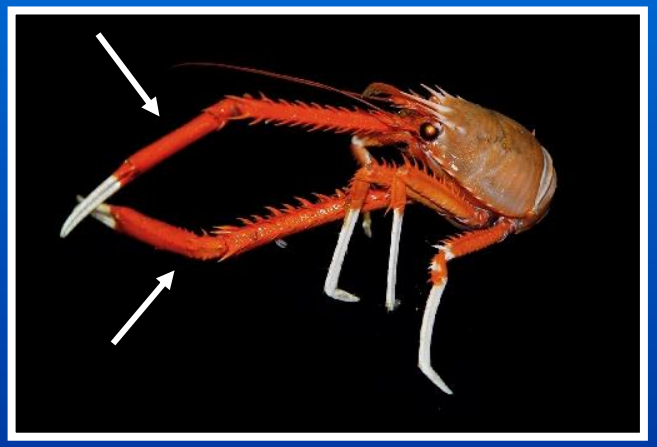
Bathypalaemonella serratipalma

None of them are bioluminescent

1) Common characteristics – extremely long claws



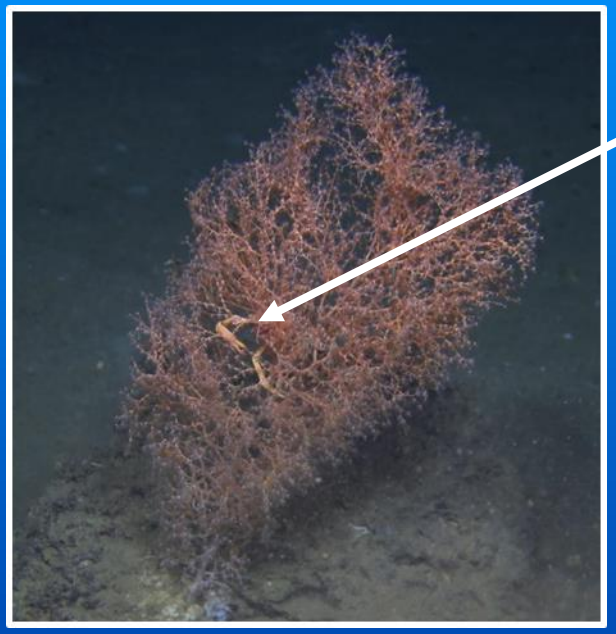
Gastroptychus spinifer

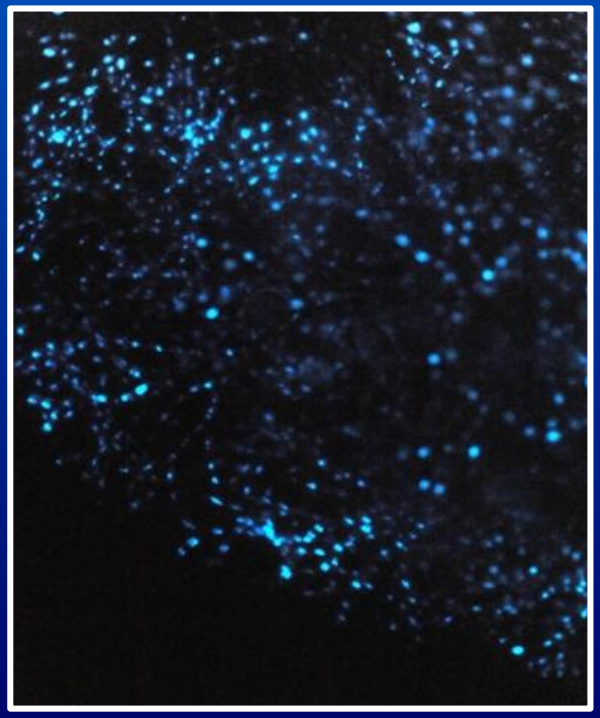


Eumunida picta

Uroptychus nitidus

Bathypalaemonella serra






PELICAN
Bioluminescence spectra
Can identify just about everything
Visual pigment opsins

Questions?